



HYDRO-CHEMICAL AND HYDRO-BIOLOGICAL RESEARCH OF THE WATER FROM THE RIONI

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ABSTRACT

We have studied hydro-chemical and microbiological condition of the Rioni in Kutaisi. The Rioni is the largest river which flows through the whole territory of Georgia. It starts on south slopes of Caucasus Mountain on Mount Phasis and flows into the Black Sea near Poti. There are several cities on the river banks, including Kutaisi. Due to maltreat by the population the river is polluted while flowing through the city. The water from the Rioni is a main healthcare point of the city population and its sanitary norms have a great practical importance. The water contains some organic substances that create favorable conditions for development of micro organisms. Combination of nitrate with food and water can have toxic influence on human being.

We have studied chemical and microbiological characteristics of the river water in Kutaisi first in 2011, 2013 near the White Bridge and then in 2014 near both ends of Kutaisi. All the approved methods have been used in hydro-chemical analysis. In order to find microbiological pollution intestinal stick *Escherichiacoli* is identified, its existence shows us the Contamination index of the water with fecal masses.

We have measured the content of particles, sulfates, and mineralization and oil products in the water with the help of classical gravimetric method. Mg^{2+} and Ca^{2+} ions have been identified with easy fast and good replication complex monetric method, Cl^- ion with mercurimetric method, HCO_3^- ions with acidometric method, biogenic substances (NH_4^+ with sodium salicycate, but NO_2^- with Gress reaction) colour and overall iron was defined with photometric methods.

Oxygen dissolved in water and biological consumption of oxygen with iodometric method, chemical consumption of oxygen with permanganatometric and bichromatic method. The acidity index has been defined with potentiometric method. The experiment suggested that the concentration of above mentioned ions and lactozopositive intestine in the water exceeds the permissible norms. The analyses results clearly indicate that Kutaisi has the greatest fault in the water pollution because open utility sewage flows into the Rioni.

Generally microbiological pollution can be assessed as epidemiologically safe.

KEYWORDS :

Introduction

The river Rioni (length 327km, width 13400km³) is the largest river which flows through the whole territory of Georgia. It starts on south slopes of Caucasus Mountain on Mount Phasis at 2960 m from above the sea level and flows into the Black Sea near Poti.



Pic 1. Riv Rioni to Kutaisi

The Rioni is characterized by its landscape diversity, which affects its hydrological regime. It nourishes with glacier, snow, rain and underground water. The river Rioni and its left and right tributaries are served as irrigation (mashveli and Adjameti canals), as well as water supply of former factories. Several towns are situated on the Rioni banks: Oni, Ambrolauri, Kutaisi, Samtredia and Poti. It is rich with different species of fish.

Due to maltreat by the population the river is polluted while flowing through the city. The ecologic condition of the water reflects on fish in the river, which the population uses as food.

Man has influenced on the biosphere since their origin, they have used its resources that cause profound changes in biosphere. Environmental problems are one of the state principal tasks, especially due to the importance of water. [1].

Water is a universal solvent for substances that are related during its circulation. Gases are transferred from air to water and solid substances from rocks and minerals. Climate has an important role for formation of underground water, which makes the atmospheric

sediments to get into the water, the amount of ions and anions in the water reservoirs depend on the soil type, the season of the year and the time of the day. The sanitary condition of the water surface has a great influence on underground water structure [2].

As the water from the Rioni is a main healthcare point of the city population and its sanitary norms have a great practical importance, we decided to study chemical and hydro-biological condition of the world. Water is the basic for our planet. It is the most common, unique, simple, at the same time the most difficult and mysterious substance on the Earth. With its physical, chemical and quantum mechanical characteristics water has special place in nature and plays a significant role in existence of organic life.

Water pollution is one of the biggest problems in modern world, which is due to human activities. Quite often mineral fertilizers, pesticides, household and industrial water flows into the river without any cleaning.

Creating new fields of industry and technique produces new source of pollution for waste water. It increases the amount of components to be examined, this requires to develop new methods of analytical control and cleaning [3].

During its centuries existence people have had known almost all kind of chemical compounds. Some of them were necessary for their normal life. Some of them are still in adaptation process. Civilization is often followed by producing new substances. Colossal amount of these substances are concentrated in the environment in direct and indirect way. Even today this process is still taking place and influences on chemical characteristics of nature [4].

Water pollution leads us to the fact that it becomes useless to drink, wash or even technical purposes. Pollution has a devastating impact on fish, water birds and other organisms, which get sick and often die for this reason.

Combination of nitrate with food and water can have toxic influence on human being. Nitrates are resurrected to nitride in intestines and small

intestines and then nitrozo ions are collected in the blood. Nitrozo ions can oxidate Fe^{2+} to Fe^{3+} in the blood hemoglobin causing coordination between Fe^{2+} and O_2 to lower the oxygen to the hemoprotein [5].

Despite its viscosity oil leaking in the ground reaches underground water and it spreads long distance. Due to its hydrophobic nature oil creates a liquid app over the water surface, which prevents the air from mixing the water. As a result all kind of animals die under this layer. Oil that flows into water dissolves microbiologically, but this is a very slow process [2].

Water is a natural environment for existence of microbes, especially its deep layers, which is protected from sunlight influences. It contains organic substances and creates favorable conditions for development of micro organisms. Rapid waters are much less likely to contain microbes than calm waters. Some microorganisms use organic substances in the water as food and transform them into mineral elements, thus plays important role in forming chemical composition of water [3].

Experimental part

We have studied chemical and microbiological characteristics of the river water in Kutaisi first in 2011, 2012, 2013 near the White Bridge and then in 2014 near both ends of Kutaisi. We have identified following indicators: water temperature, colour, weighted particles per mg/l, PH, oxygen dissolved in water mg/l, biological consumption of oxygen 5 mg/l, chemical consumption of oxygen mg/l, Mg^{2+} mg/l, Cl^- mg/l, SO_3^{2-} mg/l, mineralization mg/l, NH_4^+ mg/l, NO_2^- mg/l, NO_3^- mg/l, total iron mg/l, oil mg/l, Marginal sanitary norms mg/l, lactozopositive intestine sticks - *Escherichia coli*. Analysis has been carried out in September. Pic.2.

Hydro-chemical and microbiological research of the river Rioni in Kutaisi has been carried out by us since 2011. The analyses were conducted in Laboratory of Analytical Chemistry and Microbiology at Akaki Tsereteli State University.



Pic 2. River Rioni near the Witebridge

Approved methods have been used for analysis [6, 7, 8, 9].

Colour has been identified with photometric method with the help of standard scale of cobalt-dichromatic in degrees.

The acidity indicator (pH) was measured by a potential metric method (Potentialmeter ph 673-M). The amount of water combined substances has been identified with gravimetric method after drying Natan at $110^{\circ}C$.

The content of calcium and magnum as well as total hardness of the water has been identified with complexonometric method. The influence of heavy metals has been avoided by adding N_2S .

Acidometric method has been used in order to identify hydro carbonates. 0 1-0 01N Solution of hydrochloric acid has been used, while methylorange has been used as indicator. Chlorides have been identified with mercurimetric method.

Biogenic substances have been identified with photometric methods: NH_4^+ with Nesler reactive, NO_3^- - Sodium silicilate and NO_2^- Gress reaction.

The content of sulfates has been identified with classical gravimetric method (precipitation form $BaSO_4$). Gravimetric method is recommended by ISO in order to determine Sulfate ions its identification limit is 10mg/l.

In order to find out the concentration of organic substances in water we applied permanganatometric and bichromatic oxidation methods. Total iron concentration has been identified with photometric method. Sulphosalicylic acid has been used as photometric reactor. Aboventioned method is based on reaction between the iron oins and Sulphosalicylic acid in alkaline. The intensity of the colour is proportional to the concentration of iron.

Iodometric method has been used in order to identify oxygen dissolved in water. We have added mangamum (II) chloride and potassium alkali solution to the water, then kept sediment together with basic liquid till its maturation. We have filtered it with 0,01 n sodium thiosulfate solution with the presence of indicator starch.

Biological consumption of oxygen has been identified with idiometric method five days later of the sampling.

Mineralization has been identified with gravimetric method. We have evaporated filtered water and dried the remains until constant weight.

Oil products have been identified with classical gravimetric method in combination with extracting. We have extracted oil products with the help of chlorophyll [1].

In order to find out microbiological pollution we have identified intestine sticks - *Escherichia coli*, its existence shows us the Contamination index of the water with fecal masses. That's why we have used filtration method [6], we have a consistent number of dilutions and included it in the test tubes. We have cultivated in thermostat at $43^{\circ}C$ during 24 hours, if the crops do not produce turbidity, then the research was finished at this stage, and the response was negative. When turbidity occurred, we moved on next stage of research, to do this we used to sow the material with the help of differentiation-diagnostic dishes. Producing of red metal shining colons indicated the existence of *E.coli* in water [6].

Results and discussion

The results of the analysis are given in the table 1. According to the results the content of dissolved oxygen, cations (Mg^{2+} , Ca^{2+} , NH_4^+), anions — *CISO*, (24,,2NO), 3—*NO* biological consumption of oxygen 5, chemical consumption of oxygen and oil products is changing in wide area of territory.

The water temperature of Rioni in Kutaisi was the highest in 2013 with $19^{\circ}C$, the lowest 2012 with $12^{\circ}C$. As well the temperature in the lowest point of Kutaisi is higher ($17^{\circ}C$) than in the highest point ($16^{\circ}C$).

The smell in the water was not felt in the research years. The most colouring of the water on the city territory had in 2013 with 40 degrees, and the lowest colouration index was in 2011 with 10degrees. In 2014 the coloration of the water in the highest and the lowest point of the city was equal with 20 degrees.

Hydrogen indicator – PH in 2011, 2012 and 2013 is the same and varies between 7.38 – 7.43, in 2014 in the highest point of the city it was 7.63 whereas in the lowest point it was 7.60.

Particles mixed with the river water was the most in 2012 97.32 mg/l, the lowest was in 2011 67.14 mg/l which in our opinion is due to decrease of the wood along the river banks. This year the amount of the particles mixed with water is much less in the highest point of the city 90 63 mg/l while their amount is increasing in the lowest point of the city 120 29 mg/l.

Content of Oxygen dissolved in water is satisfactory. The highest is in 2012 with 10.67 mg/l, the lowest is in 2011 with 7.78 mg/l.

BCO5 - changes according the years. The highest is in 2013 with 2 45 mg/l and the lowest is in 2011 with 2.0 mg/l. in 2014 BCO5 in the lowest point of the city is more 4 94mg/l than in the highest point (2 36mg/l)

CCO – changes according the years in wide areas. The highest is in 2013 with 39 30 mg/l, the lowest is in 2011 with 8 50 mg/l. in 2014 it is higher in the highest point of the city with 14 08mg/l than in the lowest point 10 92mg/l which is caused with water pollution on this territory of the city.

Mg²⁺ ion content is the highest in 2012 with 12 60 mg/l, and the lowest is in 2014. In the highest point of the city it is 4 33 mg/l while it increases in the lowest point of the city with 8 08 mg/l, which is caused by the worsen sanitary conditions of the Rioni. The river is polluted by waste water from agricultural objects and public laundries.

Ca²⁺ ion content is the highest in 2013 with 24 39 mg/l and the lowest is in 2011 with 16 97 mg/l. In 2014 it is higher in the lowest point of the city 20 06 mg/l than in the highest point of the city 17 42 mg/l, which is caused by reduction of PH, that leads the whole process to mix insoluble calcium compounds into the water.

Maximum concentration of Cl⁻ ion is fixed in 2012 with 4 71 mg/l, while the minimum concentration is in 2014 in the highest point of the city 2 15 mg/l. In 2014 concentration of chloridions in the lowest point of the city is higher 2 85 mg/l than in the highest point.

The content of hydrocarbonats changes according the years. Their concentration is the highest in 2013 with 130 13 mg/l. In 2014 in the highest point of the city it is 112,36 mg/l while it is 121.7 mg/l in the lowest point of the river.

The content of sulfate ions changes in the Rioni water in the highest and lowest points of the city. -24SO ions are the highest in 2013 with 38.8 mg/l, and the lowest is 2011 with 18.17 mg/l. Its concentration is higher in the highest point of the city 27.50 mg/l while it is comparatively less in the lowest point 24.31 mg/l everything is caused by the water pollution and producing insoluble iron compounds in water.

Maximum concentration of mineralization is in 2013 with 213.5 mg/l, minimum is in 2011 with 17.39 mg/l. In 2014 it is higher in the lowest point of the city 191.7 mg/l than in the highest point 187.9 mg/l which in our opinion is caused by flowing dissoluble components into the water during the mudflow.

In 2014 the Rioni was the most polluted with ammonium nitrogen. Maximum concentration of ammonium nitrogen in the lowest point of the city was 2.84 mg/l while its minimum concentration was in 2012 with 0.16 mg/l.

The pollution with nitrous nitrogen was maximum in 2013 with 0.043 mg/l, while its minimum concentration was in 2011 with 0.007 mg/l. In 2014 the concentration of nitrits increased in the lowest point of the city with 0.025 mg/l, in the highest point it is 0.013mg/l.

Nitrous nitrogen pollution is changing over the wide area of territory. Maximum is in 2013 with 2.21 mg/l. minimum is in 2014 in the lowest

point of the city 0.25. The reduction of nitrous ions in water is caused by higher concentration of the ions with restorative abilities.

Agricultural activities and using mineral fertilizers have serious negative impact on the Rioni water resources.

Overall iron content decreases from 2011 with 0.07mg/l until 2013 with 0.01 mg/l. In 2014 in the highest point of the city it is 0.08 mg/l while it is decreasing in the lowest point of the city and that causes the water pollution. Municipal sewage, industrial and medical wastewaters deliver such substances in the water which create insoluble substances in the water.

The concentration of oil products in the Rioni changes over the years, it is the most polluted in 2012 with 0.19 mg/l. In 2014 it is 0.03 mg/l in the highest point of the city while it is 0.038 mg/l in the lowest point of the city. The increase of oil products in the water is related to several petrol stations nearby the river banks, spilling the oil products on the ground which afterwards is taken to the river.

So Kutaisi has a great fault in the Rioni pollution. The small rivers that are transformed into open sewage collectors flow into the Rioni without any cleaning or after partial local cleaning.

Pic 3. Rioni after Kutaisi

The river Rioni with its tributary Oghaskura is polluted with oil products. Its basin is contaminated with toxic as well as microbiological indicators. Pic.3.

Microbiological research analysis (table #1) shows that the degree of the Rioni water pollution remains the same during several years (2011, 2012 and 2013) though it exceeds the norm. In 2014 microbiological research of the water was carried out in the highest and lowest points of the city. According the results the pollution index exceeds the norm in the highest point of the city, while it is quite high in the lowest point of the city (7000). Such undesirable condition of the river Rioni and its tributaries is explained by different pollution sources, such as:

Waste water from different factories is flown into the Rioni. In addition to waste water, industrial and household water from food facilities, medical institutions, carwash and car service the Rioni is mostly polluted by utility sewage and runoff water from farms. City landfills are located near the river banks. Summing up all abovementioned facts and figures such changes in microbiological indicator can be explained by the absence of water treatment facilities. The situation would have been worse if the river hadn't had natural self-cleaning feature.

Microbiological pollution can be assessed as epidemiologically safe

Table 1. Chemical and microbiological characteristics of the Rioni water (2011, 2012, 2013 and 2014)

Date	name	Water temperature	Smel point	colour	Weighted particles Mg/l	pH	Oxygen dissolved in water	BCO	CCO	Mg ²⁺	Ca ²⁺	Cl ⁻	HCO ₃ ⁻	SO ₄ ²⁻	Mineralization	NH ₄ ⁺	NO ₂ ⁻	NO ₃ ⁻	Over all iron	Oil products	MSN	MPC	Lactose additional E. coli
Mg/l																							
2011	Riv. Rioni city territory	19 5	0	10	67 1 4	7 38	7 78	2 0	8 50	5 56	16 9 7	3 20	114.9 6	18 1	173 9	0 38	0 00 7	0 6	0 07	0 07 5	0 02	1000 0	5000 0
2012	Riv. Rioni city territory	12 1	0	15	97 3 2	7 38	10 6 7	2 24	14 9 6	12 6 0	19 5 3	4 71	128.0 4	20 3 8	216 5	0 16	0 01 2	0 8	0 01	0 19	0 03 6	1000 0	4000 0
2013	Riv. Rioni city territory	19 0	0	40	70 4 2	7 43	7 88	2 45	39 3 0	9 4	21 3 4	2 98	130.1 3	37 8 7	213 5	0 85	0 04 3	2 21	0 01	0 14	0 00 6	1000 0	5000 0

2014	Riv. Rioni the highest point of the city	16 6	0	20	90 6 3	7 63	9 23	1 94	14 0 8	4 33	17 4 2	2 15	112.3 6	24 3 1	182 9	1 98	0 01 3	0 5	0 08	0 03	0 00 8	1000 0	4000 0
2014	Riv. Rioni the lowest point of the city	17 1	0	20	128 29	7 60	8 92	2 36	10 9 2	8 08	20 0 6	2 85	121. 17	27 5	191 7	2 84	0 02 5	0 25	0 04	0 03 8	0 00 4	1000 0	7000 0

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